Final Report to NASA for grant NAG5-6597

A Computer Learning Center for Environmental Sciences

http://earthlab.geo.brown.edu/earthlab.htm

Dr. John F. Mustard (PI)
Department of Geological Sciences
Box 1846
Brown University
Providence, RI 02912
401-863-1264 (ph)
401-863-3978 (fx)
John_Mustard@brown.edu

Overview:

In the fall of 1998, MacMillan Hall opened at Brown University to students. In MacMillan Hall was the new Computer Learning Center, since named the EarthLab which was outfitted with high-end workstations and peripherals primarily focused on the use of remotely sensed and other spatial data in the environmental sciences. The NASA grant we received as part of the *"Centers of Excellence in Applications of Remote Sensing to Regional and Global Integrated Environmental Assessments"* was the primary source of funds to outfit this learning and research center. Since opening, we have expanded the range of learning and research opportunities and integrated a cross-campus network of disciplines who have come together to learn and use spatial data of all kinds.

The EarthLab also forms a core of undergraduate, graduate, and faculty research on environmental problems that draw upon the unique perspective of remotely sensed data. Over the last two years, the Earthlab has been a center for research on the environmental impact of water resource use in arid regions, impact of the green revolution on forest cover in India, the design of forest preserves in Vietnam, and detailed assessments of the utility of thermal and hyperspectral data for water quality analysis. It has also been used extensively for local environmental activities, in particular studies on the impact of lead on the health of urban children in Rhode Island. Finally, the EarthLab has also served as a key educational and analysis center for activities related to the Brown University Affiliated Research Center that is devoted to transferring university research to the private sector.

The range of activities has advanced tremendously since the installation and staffing of the EarthLab. The NASA grant paid for all the initial hardware, software, and staffing for the installation. Since then the university has stepped in to pick up the costs of hardware and software maintenance, as well as a full time position to serve as system manager and resource facilitator, Lynn Carlson. Before this grant, there was limited and rudimentary Geographical Information Systems knowledge and application on campus, and the use of remotely sensed data was largely limited to one highly successful research group. Over the last two years the use of remotely sensed data beyond research has

improved dramatically. More importantly, the use of GIS has practically exploded. Where once Brown University had no presence in this important technology, we now have a site license, a dedicated user group, multiple workshops and self study programs, and two new courses offered. In addition, while the grant paid the cost of the university site license the first year, due to the overwhelming response of the community to this, and our efforts to promote the availability and training in the software, the university has agreed to pick up the continuing costs of this site license.

Hardware and Software:

The philosophy for the EarthLab was to create a dedicated system that worked with industry standard software, served by a high capacity central server, linked to high quality true-color workstations, and that would operate at a high level of security and stability. We also did not intend this to be "just another computer cluster" and wanted to distinguish the operations from locations that were devoted to email and class homework assignments. The natural choice then and the natural choice we believe today, is a UNIX network of workstations connected to a high capacity server.

MacMillan Hall was wired from the beginning to have excellent telecommunications. The building has Cat-5 as well as fiber optic wiring. We then requested that the networking hardware for the learning center and affiliated research units be connected with 100 mbit/sec switched hardware to speed the transfer of large data files simultaneously across the network. Thus the university invested up front in a forwarded looking manner to establish a facility that can grow with data and hardware capability. We believe the foundations set with the NASA grant will provide at least 15 years of capability before major efforts are required to accommodate changes. If fiber optic systems develop and are enhanced then the infrastructure underlying this facility will be able to sustain continued growth and evolution for 20-25 years.

Our original objectives were to have a compute server with 512 megabytes of RAM, 90 gigabytes of storage with a 4 mm and 8 mm tape drive. The workstations were expected to be 200 MHz processors with 17" color monitors and 128 megabytes of RAM. We also envisioned having 3 digitizing tablets and a color laser printer. Software included an ESRI ARC/INFO University site license, additional PCI licenses, and 10 ENVI licenses. Not surprisingly, between the time we submitted the grant and the time we purchased the equipment, there had been significant changes in the pricing and capability of hardware. In the final analysis, we significantly exceeded the originally envisioned capabilities. Specifically all the hardware was more capable (more RAM, faster processors, etc.); we were able to obtain 21" color monitors, 2 additional workstations, two additional printers (black and white as well as wide format), and a Cdrom writer.

Below is a list of hardware acquired with the NASA grant.

Sun Enterprise 450 Server

- Dual 300 Mhz UltraSPARCII CPU
- 1 Gigabyte of RAM
- 90 Gigabytes UltraSCSI storage
- Quad Ethernet connection to network (450 mbits/sec transfer rates)
- 72-144 GB 4 mm DDS tape drive for backup
- 7-14 GB 8 mm tape drive
- 3 year maintenance contract

12 Sun Ultra 10 Workstations

- 300 MHz UltraSPARC-IIi processor
- 256 Megabytes of RAM
- 24x Cdrom
- Creator 3D Series 3 graphics cards

12 21-inch Color monitors

External 4 mm and 8 mm tape drives

Cdrom writer

HP b/w laser printer

QMS Magicolor II color laser printer

HP 3 ft wide larger format printer

3'x4' digitizing tablet

Below is a list of software acquired with the NASA grant (note, all software was acquired as the initial cost for a year contract. Subsequent maintenance fees paid by the university).

ESRI Full University Site License for ARC/INFO and all ESRI products

PCI Easi/Pace image processing package, full educational license

ENVI image processing package

University Contributions

Wiring of the facilities with Cat-5 and fiber optic cables

Purchase and installation of 100 mbit/sec switched networking hardware

Purchase of 12 SunPCi cards for the workstations to allow simultaneous Windows NT and UNIX operations on the same workstation

Hiring of the system manager and EarthLab facilitator

Maintenance of software, hardware

Impact

Brown University considers its mission to be a university-college. The faculty are expected to conduct high quality research with graduate students and post docs, and these same faculty teach all levels of courses and engage undergraduate students in research projects. While our research facilities are adequate to satisfy one-on-one mentoring with

undergraduate students, they were inadequate to accommodate the large numbers of students, graduate and undergraduate, who wish to become educated in the use of remotely sensed data for environmental applications. The equipment purchased with this NASA grant has gone a long way to removing obstacles to the learning and use of remotely sensed and spatial data for environmental applications. There is a much greater capacity for engaging students, and also for putting in their hands the tools to conduct original thinking, do theses, and conduct exploratory research.

Prior to the NASA grant there were two principal courses in remote sensing, both introductory courses. Since the creation of the EarthLab and outfitting it with state of the art equipment, we have seen the enrollments in both courses jump between 50-100%! (While great for remote sensing, we must also now increase the resources to accommodate so many students who we were unprepared for but have since allocated additional resources to facilitate more effective learning for them). There has also been the creation of two new courses, one in advanced remote sensing and the other an introduction to GIS. There are plans to also include an advanced GIS course once we have sufficient experience with the introductory course.

The EarthLab is also a center for promoting diversity in science. Over the past 7 years approximately 80% of the Environmental Science concentrators and over 50% of the Geological Sciences concentrators have been women. Environmental and geological sciences provide a unique way to help attract women into the sciences. We are not certain why we see such a strong affinity for environmental sciences among women, but it is clear that it is not an attempt to take a path of lesser resistance, as the degree is very demanding, and the concentrators are more successful on average than their peers (% receiving honors etc.). The pattern of more women being attracted to environmental and geological science has been noted at other schools, but there has been no attempt to document this pattern, or to understand its causal roots. Based on the our recent experience with the EarthLab we can say with some confidence that the creation of a sophisticated center for analysis of remotely sensed and spatial data has attracted more women into science and in particular into remote sensing and GIS.

One of the centerpieces of the EarthLab is the facilitator Lynn Carlson. She is available for consultation, training, and basic trouble shooting. She had over a decade of experience in GIS prior to coming to Brown, but has evolved well into a facilitator for the EarthLab. This position makes the technology accessible to an even wider array of people through personalized workshops and mini-courses.